

WHAT IS CLAIMED IS:

1. A system for bulge forming a substantially flat blank into an article which comprises a formed part and which includes a shaped portion, comprising:

18 an element for enabling the shaped portions of the article to be formed

5 thereagainst, including a portion complementary in shape to the shape of the shaped portion of the article to be formed thereby;

(22) ^{cage sections} means for enabling the form-shaping element to be enclosed therein, and for enabling the blank to be positioned and enclosed therein;

(26) ^{bladder} a flexible member, adapted to be enclosed within the enclosing enabling means, to bulge within the enclosing enabling means upon the application of pressure to the flexible member, to exert pressure on the blank adapted to be positioned in the enclosing enabling means, and to bend the blank relative to the form-shaping element complementary portion to form the shaped portion of the article; and

15 28 means for enabling expansion of the flexible-member-so-as-to-exert pressure on the blank and form the shaped portion of the article against the form-shaping element.

2. The system of claim 1, wherein the flexible member is further adapted to be attached within the enclosing enabling means.

3. The system of claim 1, wherein the flexible member is further adapted to be movable within the enclosing enabling means.

4. The system of claim 1, wherein the flexible member comprises a bladder.

5. The system of claim 1, wherein the form-shaping element comprises a die element¹⁸.

6. The system of claim 1, wherein the enclosing enabling means comprise a plurality of inter-engagable cage sections²², adapted to be secured together to enable the article shaped portion to be formed therein, and to be separated to enable the blank to be inserted therein or to enable removal of
5 the article formed therein.

7. The system of claim 1, wherein the expansion enabling means²⁰ comprise means for enabling a medium for exerting pressure on the flexible member to be pumped therethrough into the flexible member for expansion of the flexible member.

8. The system of claim 1, wherein the blank is comprised of sheet metal.

9. The system of claim 1, further comprising a plurality of form-shaping elements¹⁹, and a plurality of flexible members²⁶.

10. The system of claim 1, wherein the article in which a shaped
/ portion is to be bulge formed comprises a substantially large article.

11. The system of claim 1, wherein the article further comprises a
/ finished part.

12. The system of claim 1, wherein the article is comprised of
/ lightweight material.

13. The system of claim 1, wherein the article comprises a complex shaped article, which includes a plurality of shaped portions.

14. The system of claim 4, wherein the bladder is comprised of rubber.

15. The system of claim 4, wherein the bladder is comprised of polyurethane.

16. The system of claim 7, wherein the pumping enabling means include a tube, adapted to be connected to the flexible member.

17. The system of claim 7, wherein the pressure-exerting medium comprises hydraulic fluid.

18. The system of claim 8, wherein the sheet metal blank is comprised of aluminum.

19. The system of claim 10, wherein the article comprises an aircraft fuselage crown frame.

20. The system of claim 10, wherein the article to be formed thereby further comprises a thin-walled article.

21. The system of claim 10, wherein the article to be formed thereby further comprises a structural article.

22. The system of claim 10, wherein the blank to be formed into the article is substantially large corresponding to the substantially large article.

23. The system of claim 10, wherein the enclosing enabling means, the form shaping element, and the flexible member are substantially large corresponding to the substantially large article.

24. The system of claim 16, wherein the tube comprises a flexible tube.

25. A system for bulge forming a substantially flat blank into an article which comprises a formed part and which includes a shaped portion, comprising:

5 a form-shaping element for enabling the shaped portions of the article to be formed there against, including a portion complementary in shape to the shape of the shaped portion of the article to be formed thereby;

an enclosing enabling element for enabling the form-shaping element to be enclosed therein, and for enabling the blank to be positioned and enclosed therein;

10 a flexible member, adapted to be enclosed within the enclosing enabling means, to bulge within the enclosing enabling element upon the application of pressure to the flexible member, to exert pressure on the blank adapted to be positioned in the enclosing enabling element, and to bend the blank relative to the form-shaping element complementary portion to form the
15 shaped portion of the article; and

an expansion enabling element for enabling expansion of the flexible member so as to exert pressure on the blank and form the shaped portion of the article against the form-shaping element.

26. The system of claim 25, wherein the flexible member is further adapted to be attached within the enclosing enabling element.

27. The system of claim 25, wherein the flexible member is further adapted to be movable within the enclosing enabling element.

28. The system of claim 25, wherein the flexible member comprises a bladder.

29. The system of claim 25, wherein the form-shaping element comprises a die element.

30. The system of claim 25, wherein the enclosing enabling element comprises a plurality of inter-engagable cage sections, adapted to be secured together to enable the article shaped portion to be formed therein, and to be separated to enable the blank to be inserted therein or to enable removal of the article formed therein.

31. The system of claim 25, wherein the expansion enabling element comprises an element for enabling a medium for exerting pressure on the flexible member to be pumped therethrough into the flexible member for expansion of the flexible member.

32. The system of claim 25, wherein the blank is comprised of sheet metal.

33. The system of claim 25, further comprising a plurality of form-shaping elements, and a plurality of flexible members.

34. The system of claim 25, wherein the article in which a shaped portion is to be bulge formed comprises a substantially large article.

35. The system of claim 25, wherein the article further comprises a finished part.

36. The system of claim 25, wherein the article is comprised of lightweight material.

37. The system of claim 25, wherein the article comprises a complex shaped article, which includes a plurality of shaped portions.

38. The system of claim 28, wherein the bladder is comprised of rubber.

39. The system of claim 28, wherein the bladder is comprised of polyurethane.

40. The system of claim 31, wherein the pumping enabling element includes a tube, adapted to be connected to the flexible member.

41. The system of claim 31, wherein the pressure-exerting medium comprises hydraulic fluid.

42. The system of claim 32, wherein the sheet metal blank is comprised of aluminum.

43. The system of claim 34, wherein the article comprises an aircraft fuselage crown frame.

44. The system of claim 34, wherein the article to be formed thereby further comprises a thin-walled article.

45. The system of claim 34, wherein the article to be formed thereby further comprises a structural article.

46. The system of claim 34, wherein the sheet metal to be formed into the article is substantially large corresponding to the substantially large article.

47. The system of claim 34, wherein the enclosing enabling means, the form-shaping element, and the flexible member are substantially large corresponding to the substantially large article.

48. The system of claim 40, wherein the tube comprises a flexible tube.

49. A method of bulge forming a substantially flat blank into an article which comprises a formed part and which includes a shaped portion, in a system which comprises an element for enabling the shaped portions of the article to be formed thereagainst, including a portion complementary in shape to the shape of the shaped portion of the article to be formed thereby, means for enabling the form-shaping element to be enclosed therein, and for enabling the blank to be positioned and enclosed therein, a flexible member, adapted to be enclosed within the enclosing enabling means, to bulge within the enclosing enabling means upon the application of pressure to the flexible member, to exert pressure on the blank adapted to be positioned in the enclosing enabling means, and to bend the blank relative to the form-shaping element complementary portions to form the shaped portion of the article, and means for enabling expansion of the flexible member so as to exert pressure on the blank and form the shaped portion of the article against the form-shaping element, wherein the method comprises:

opening the enclosing enabling means and positioning the blank therein relative to the form-shaping element;

closing the enclosing enabling means; and

expanding the flexible member such that the flexible member bulges
20 relative to the blank and exerts pressure on the blank against the form-enabling element to form the shaped portion of the article.

50. The method of claim 49, wherein the flexible member is further adapted to be attached within the enclosing enabling means, and wherein expanding comprises exerting pressure from the attached flexible member within the enclosing enabling means.

51. The method of claim 49, wherein the flexible member is further adapted to be movable within the enclosing enabling means, and wherein expanding comprises exerting pressure from the moveable flexible member within the enclosing enabling means.

52. The method of claim 49, wherein the flexible member comprises a bladder, and wherein expanding comprises expanding the bladder.

53. The method of claim 49, wherein the form-shaping element comprises a die element, and wherein expanding comprises expanding the flexible member against the die element.

54. The method of claim 49, wherein the enclosing enabling means comprise a plurality of inter-engagable cage sections, adapted to be secured together to enable the article shaped portion to be formed therein, and to be separated to enable the blank to be inserted therein or to enable removal
5 formed therein, and wherein closing the enclosing enabling means comprises engaging together the sections of the enclosing enabling means.

55. The method of claim 49, wherein the expansion enabling means comprise means for enabling a medium for exerting pressure in the flexible member to be pumped therethrough into the flexible member for expansion of the flexible member, and wherein expanding comprises enabling the pressure exerting medium to be pumped through the pumping enabling means into the flexible member for expansion of the flexible member.

56. The method of claim 49, wherein the blank is comprised of sheet metal, and wherein expanding comprises expanding the flexible member against the sheet metal blank.

57. The method of claim 49, further comprising a plurality of form-shaping elements, and a plurality of flexible members, and wherein expanding comprises expanding the plurality of flexible members against the plurality of form-shaping elements.

58. The method of claim 49, wherein the article in which a shaped portion is to be bulge formed comprises a substantially large article, and wherein expanding further comprises forming the substantially large article.

59. The method of claim 49, wherein the article further comprises a finished part, and wherein expanding further comprises forming the finished part.

60. The method of claim 49, wherein the article is lightweight, and wherein expanding further comprises forming the lightweight article.

61. The method of claim 49, wherein the article comprises a complex shaped article which includes a plurality of shaped portions, and wherein expanding further comprises forming the complex shaped article.

62. The method of claim 52, wherein the bladder is comprised of rubber, and wherein expanding comprises expanding the rubber bladder.

63. The method of claim 52, wherein the bladder is comprised of polyurethane, and wherein expanding comprises expanding the polyurethane bladder.

64. The method of claim 55, wherein the pumping enabling means include a tube, adapted to be connected to the flexible member, and wherein expanding comprises enabling the pressure-exerting medium to be pumped through the tube into the flexible member.

65. The method of claim 55, wherein the pressure-exerting medium comprises hydraulic fluid, and wherein expanding comprises enabling hydraulic fluid to be pumped through the pumping enabling means into the flexible member for expansion of the flexible member.

66. The system of claim 56, wherein the sheet metal blank is comprised of aluminum, and wherein expanding comprises expanding the flexible member against the aluminum blank.

67. The method of claim 58, wherein the article comprises an aircraft fuselage crown frame, and wherein expanding further comprises forming the aircraft fuselage crown frame.

✓ 68. The method of claim 58, wherein the article to be formed thereby further comprises a thin-walled article, and wherein expanding further comprises forming the thin-walled article.

✓ 69. The method of claim 58, wherein the article to be formed thereby further comprises a structural article, and wherein expanding further comprises forming the structural article.

✓ 70. The method of claim 58, wherein the blank to be formed into the article is substantially large corresponding to the substantially large article, and wherein expanding further comprises exerting pressure on the substantially large blank.

5 71. The method of claim 58, wherein the enclosing enabling means, the form-shaping element, and the flexible member are substantially large corresponding to the substantially large article, and wherein opening further comprises opening the substantially large enclosing enabling means and positioning the blank relative to the substantially large form-shaping element, and expanding further comprises expanding the substantially large flexible member.

72. The method of claim 64, wherein the tube comprises a flexible tube, and expanding comprises enabling the pressure-exerting medium to be pumped through the flexible tube.